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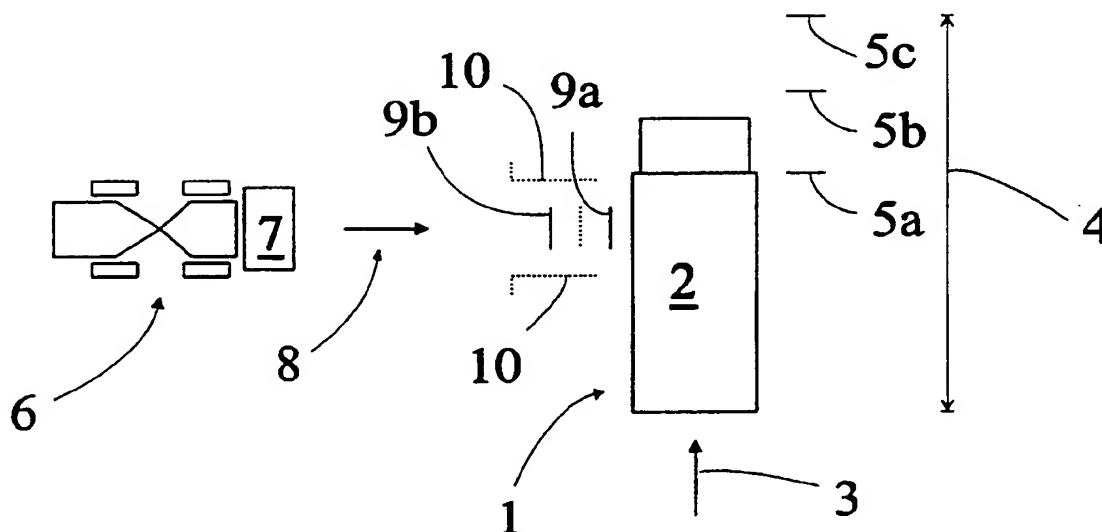
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(54) Title: METHOD AND APPARATUS FOR AUTOMATIC LOADING OF DUMPER



(57) Abstract: A method for loading a dumper with broken rock or the like and an apparatus for implementing the method. In the method, a loading area (4) is defined for the dumper (1), to which the dumper (1) is stopped at a predefined position (5a) for loading. An emptying area (10) is correspondingly defined in advance for a loader (6) for transporting the material in its bucket (7) onto the dumper (1) box (2). The apparatus comprises control means for controlling the dumper at least during loading, and the control means comprise means for stopping the dumper (1) for loading at the predefined position so that the material transported by the loader (6) can be emptied onto the dumper (1) box (2) in a predefined location in the longitudinal direction.

WO 02/083529 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND APPARATUS FOR AUTOMATIC LOADING OF DUMPER

[0001] The invention relates to a method for loading a dumper with broken rock or corresponding material in such a manner that several bucketfuls of the material are loaded by a loader on a dump box in such a manner that the loader approaches the dumper transverse to it so that the material in the bucket of the loader can be emptied from the bucket to the dump box.

[0002] Further, the invention relates to an apparatus for implementing the method according to claim 1.

[0003] In mining or other quarrying operations, broken rock needs to be transported in different ways for further processing from the quarry to a processing site. Broken rock is typically first transported in loaders that fetch the broken rock and transport it to a loading site. Broken rock is transported on by dumpers, trains or the like that return to the loading site to fetch a new load. One typical transport method is that after fetching a bucketful of broken rock the loader empties it directly on the dump box. The dump box can typically take several bucketfuls, which means that when loading, the operator needs to empty the bucket at different points in both longitudinal and transverse direction of the dump box so as to fill the box as well as possible. Because the operator does not, however, see when the box is full, it is always to some extent unevenly filled, and the process difficult for the operator. The situation is the same when an autonomously moving dumper controlled by a computer is used, because the operator of the loader cannot see the inside of the box. New solutions are required, if a fully automated dumper loading is to be achieved, in which both the dumpers and loaders operate autonomously controlled by a computer.

[0004] It is an object of the present invention to provide a method and an apparatus, with which the loading of a dumper is easier and simpler than now and with which loading is more efficient than before.

[0005] The method of the invention is characterized in that the loading site has a predefined loading area, where the dumper is stopped in a predefined position for loading; that a predefined emptying area is defined for the loader in said loading area at the side of the dumper, to which the loader drives for the purpose of emptying the material in its bucket on the box of the dumper; that to fill the box of the dumper in the desired manner in transverse direction, the loader is stopped at different points transverse to the dumper, and thus longitudinal to the loader, according to the filling degree of the box and de-

pending on the loading situation of the dump box area being loaded at the time; and that to load the dump box in its longitudinal direction in the desired manner, the dumper is moved, when one area of the box has been loaded, in longitudinal direction or the emptying area of the loader is moved in the longitudinal direction of the dumper a predefined distance so as to load the next area of the box.

[0006] Further, the apparatus of the invention is characterized in that it comprises control means for controlling the dumper at least during loading; that the control means comprise means for stopping the dumper in the loading area in a predefined position so that the material transported by the loader can be emptied on the dump box at a predefined point in its longitudinal direction and, when the dump box is loaded at a certain longitudinal point of the box, for moving the dumper in longitudinal direction or for moving the emptying area of the loader in the longitudinal direction of the dumper a predefined distance so as to load the next area of the box.

[0007] An essential idea of the invention is that the dumper is most preferably stopped automatically in a specific predefined loading area, to which the loader in turn transports a load along a specific route that is transverse to the direction of travel of the dumper to a predefined emptying area at the side of the dumper and empties its bucket on the dump box at different points in the transverse direction of the dump box depending on the loading situation. This way, the filling of the box is controlled in its transverse direction by driving the loader either further away from the dumper or closer to it depending on which side of the box the load is to be emptied. A further essential idea of the invention is that during loading, the dumper is moved most preferably automatically in its longitudinal direction in a manner suitable for the loading so that the load emptied from the loader drops on the dump box at a suitable point in its longitudinal direction, in which case the longitudinal filling of the box is correspondingly controlled by moving the dumper to a suitable point. This way, the dump box can be appropriately filled by controlling the filling of the box in the longitudinal direction of the dumper by means of the longitudinal position of the dumper and in the transverse direction by means of the longitudinal position of the loader. The essential idea of a preferred embodiment of the invention is that it comprises separate measuring means for measuring the amount of load on the dump box: height, weight, etc., and for controlling the loading on the basis of the measurements in such a manner that when the amount of the load

on the dump box at the current loading point exceeds a predefined value, the dumper is moved in its longitudinal direction or the emptying area of the loader is moved in the longitudinal direction of the dumper so that the next load brought by the loader drops at an emptier point of the box, or if the entire box is full, the dumper leaves to empty the box most preferably automatically controlled by a computer. According to a second preferred embodiment of the invention, the loading site is such that in a loading situation, the dumper is substantially lower than the loader, preferably below the loading area of the loader. According to yet another preferred embodiment of the invention, the loading site has a funnel-shaped guide located above the dump box in the loading situation so that the broken rock from the bucket of the loader drops entirely inside the dump box.

[0008] The invention provides the advantage that with the use of an automatically controlled dumper, loading can be automated and controlled easily so that the load transported by the loader always drops on a suitable area of the box so as to have a sufficiently high load in the dumper suitably distributed on the entire box. In fully automated loading, where both the loader and the dumper operate automatically under the control of a computer, the control and guidance of loading is simple and easy, because the longitudinal filling of the box is most preferably controlled by moving the dumper and, correspondingly, the transverse filling is controlled by guiding the movement of the loader in its longitudinal direction, which makes the control simple and easy. This, in turn, is based on the fact that it is necessary to control only the movement and length of movement of either machine in one direction and complex and difficult two-dimensional movement control is not needed.

[0009] The invention will be described in greater detail in the attached drawings, in which

Figure 1 is a schematic top view of loading material with a loader to a dumper by applying the method of the invention,

Figure 2 is a schematic representation of a preferred embodiment of the invention as seen from behind a dumper,

Figure 3 is a schematic top view of the preferred embodiment of Figure 2 shown in the same way as in Figure 1, and

Figure 4 is a schematic representation of an embodiment of the invention, in which the emptying area of the loader is changed according to the load situation of the dump box.

[0010] Figure 1 shows a dumper 1 that runs automatically under the control of a computer and has a box 2 for transporting a load, in this case broken rock. The dumper moves along the route marked by arrow 3, for instance, and stops in the loading area shown by arrow 4 in the manner indicated in the figure, i.e. where the loading area 4 begins, so that the front edge of the box 2 is at the location shown by line 5a. When the dumper is at this location, a loader 6 having a bucket 7 arrives as shown by arrow 8 to empty the material, such as broken rock, in the bucket 7 onto the box 2 of the dumper 1. So as to be able to load the box in a desired manner, an emptying area is defined for the loader 6 in the loading area in the longitudinal direction of the dumper, to which the loader 6 drives when transporting material for the dump box. So as to fill the box 2 in a suitable manner, the front edge of the loader or some other measurement or comparison point is driven substantially perpendicular to the transverse direction of the box 2 until the level shown by line 9a, for instance, so that when the bucket 7 is tipped, the broken rock falls over the centreline of the box 2 to the right-hand side in the figure. Correspondingly, when transporting the next bucketful, the loader stops at the location shown by line 9b, in which case the broken rock in the bucket 7 falls to the left-hand side of the box 2 in the figure. This way, an even load is achieved in transverse direction at a given location in the longitudinal direction of the box. If the box volume and load-bearing capacity of the dumper permits, it is also possible to use for instance the location marked with a dashed line midway between lines 9a and 9b for emptying the bucket load of the loader in the middle of the dump box in its transverse direction. The marked locations, such as lines 9a and 9b, can naturally also be defined otherwise in relation to the loader, for instance at the wheels or at the back end, as long as the stopping points of the loader in the transverse direction of the dumper are explicitly defined and detectable so the loader can be guided according to them. The detection can be done for instance by using a suitable distance gauge or the like at the front end of the loader to measure the location of the loader in relation to the loading area of the dumper and thus also to the dumper in its transverse direction. Depending on the size of the loader bucket and the dump box, which affects the number of bucketfuls the loader can transport to one location in its transverse direction, it is possible to define in advance more than one emptying area for the bucket, and their locations are naturally selected in accordance with the equipment being used. After the front section of the box is filled while the dumper is in the

position according to the figure, the dumper is moved forward until the front edge of the box 2 is approximately at line 5b. Correspondingly, the box is here filled in transverse direction in the same manner as at line 5a and further, if the length of the box is such that its loading requires three consecutive loading points, the dumper is run forward until the front edge of the box is at line 5c and the loading in transverse direction is done according to the earlier description. When the dump box 2 is full, the computer sends a notification or fully automatically directs the dumper along a defined route to empty its load and to return to be reloaded in the manner shown in Figure 1. The situation of Figure 1 shows one dumper and one loader to simplify the matter. In practice, several loaders may load one dumper, which is more efficient, and correspondingly, when one dumper leaves the loading site to empty its load, a second dumper can drive immediately after it to the site to be loaded so that loading is substantially continuous for both dumpers and loaders without any breaks that would reduce output.

[0011] In the situation shown in Figure 1, the dumper and loader can, in principle, be level with each other, because the bucket of the loader extends above the edges of the dump box. If the loader is manually controlled, positioning it is easier when using controls, which are indicated by dashed lines 10 in the figure, either marked in the body or made up of separate control posts or other controls so as to allow the correct positioning of the loader in the emptying area in relation to the longitudinal position of the dumper. So as to maintain a suitable amount, i.e. in practice height, of load in the dumper, the load of the dumper can be monitored with separate measuring devices, by means of which the height and/or weight of the load on the box and preferably also the location of the load on the box and possibly its shape can be defined. This is described later in connection with the other figures, but on the basis of the information provided by such measuring devices, a computer, for instance, can determine that the load at a certain point of the box is sufficient and move the dumper a required distance forward or send it to empty its load.

[0012] Figure 2 is a schematic representation of the loading situation of a preferred embodiment of the invention as seen from the back of the dumper. In this case, the position of the dumper in the loading situation is in elevation clearly lower than the position of the loader, in which case the dumper can even be completely below the travelling level of the loader as shown in the figure. In this situation, loading takes place in principle in exactly

the same way as in Figure 1, but the load falls further down. In this embodiment, there may be a downwards-convergent guide edge 11, shown in cross-section in the figure, located above the loading site of the dumper and at the location of the dump box and extending to the inside of the dumper 1 box 2 edges so that all material falls on the dump box. This detail is shown in Figure 3 in a corresponding manner to Figure 1 from the top.

[0013] This embodiment also shows above the loading point a measuring device 12 that is used to define the height and possibly also the shape of the load on the dump box 2 at the loading point. The measuring device 12 can be a laser scanner, video camera or another suitable measuring device for monitoring the load on the box, especially its height and possibly also its shape. This load definition can also be used to guide the loader in such a manner that its stopping point in the transverse direction of the box 2 can change according to the manner in which the load has settled on the box after earlier bucketfuls. In principle, it is possible to use any suitable stopping point in the direction of travel of the loader and it is not necessary to limit it to the stopping points shown by lines 9a and 9b in Figure 1. Especially when using a loader that runs automatically controlled by a computer, controlling the loading process by means of the measuring device 12 is easy and reliable, and the dump box can this way be loaded in such a manner that as large an amount of broken rock as possible can be transported each time. The figure also shows two other measuring devices 12a and 12b that are located under the cover of the guide edge 11 so that they can measure the height and/or shape of the load in transverse direction.

[0014] In addition to measuring the height, shape and location of the load, the load of the dumper can also be measured with other, different measuring means. Strain gauges or other gauges mounted on the body of the dumper can be used for this purpose to define by direct measurement the weight of the load on the dump box and preferably also its location on the box. The use of such gauges and measuring means indicating measuring values, which are directly proportional to weight, are generally known per se and they are commercially generally available, which is why they need not be described in more detail herein.

[0015] Figure 3 shows a solution corresponding to Figure 2 from the top, in which case it shows how the guide edge 11 extends inside the edges of the dump box marked with a dashed line and guides in both transverse and

longitudinal direction the rock pieces, which possibly fall from the loader bucket to a wider area, to the desired area on the box. The opening of the guide edge 11 is of course approximately equal in width to the loader bucket or longer than it in the direction of the dump box so as to permit the broken rock to fall as easily as possible onto the box. The guide edge 11 is mainly needed to guide blocks that accidentally fall outside the normal emptying area onto the box.

[0016] The invention can also be applied in another manner as shown in Figure 4, in which measuring means are used to define the position of the dumper and the operation of the loader is guided on the basis of the thus defined dumper position. The loading area or site is then not fixed as in the embodiments described above. In this embodiment, when the dumper arrives at the loading area, i.e. inside certain predefined limits, it stops. As a result of this, measuring means automatically measure what the dumper position is in said area in relation to the measuring means. When the loader brings a load to the dumper, a control signal is transmitted to an apparatus in it to guide the loader along a suitable path in relation to the dumper in the transverse and longitudinal direction of the dumper as appropriate for the loading situation. If the loader is fully controlled by a computer, the computer runs the loader and no actual display is needed for the operator. Loading can then also be done in such a manner that it is not necessary to move the dumper in its longitudinal direction, but the computer guides the route of the loader as shown by arrows 10a to 10c to be suitable with respect to the longitudinal direction of the dumper on the basis of the amount and location of the broken rock already loaded onto the dump box. In this embodiment, the emptying area of the loader is defined in the longitudinal direction of the dumper, i.e. the area is moved to the side of the dumper according to the loading situation, and the loader drives to each emptying area according to the control commands. This solution can also be applied to embodiments having a separate different-level loading site for the dumper and an edge guiding the rock. In this situation, it is, however, possible to use a guide edge having a funnel opening substantially equal to the size of the dump box.

[0017] To ensure an even distribution of the load, it is also possible to measure the weight of the load. In such a case, not only is the location and shape/height of the load on the box measured, but also the weight distribution of the load on the box is determined. For instance, if the broken rock being loaded is very heterogeneous containing blocks of different sizes, measuring

the shape of the load only may lead to an uneven weight distribution on the box. This in turn may lead to a malfunction in the dumper at least over a long period of time. Thus, weight measurement can prevent uneven loads and consequently ensure correct operation of the equipment.

5 **[0018]** The invention is in the above description and in the drawings described by way of example only and it is in no way limited to them. An essential point is that loading in the longitudinal direction of the dumper is controlled by moving the dumper in a suitable manner for loading, most preferably automatically, in the longitudinal direction of the dumper, or by moving the
10 emptying area of the loader in the longitudinal direction of the dumper so that the rock loads transported by one or more loaders settle as evenly as possible on the box of the dumper. Further, another essential point is that during the transverse-direction loading of the dump box the loader is guided in the transverse direction of the dumper, i.e. its direction of travel is guided, most preferably
15 automatically so that the rock transported by the loaders can also be loaded as evenly as possible in the transverse direction of the box, resulting in a most suitable loading of the box. Loading is preferably done as automatically as possible so that at least the emptying of the loader bucket is automatically controlled by control means, but if possible, the entire operation, from the
20 loader fetching the material to the movement of the loader between the loading site and the emptying area and the emptying of the bucket, is automated under the control of control means. Correspondingly, the movement of the dumper at its loading site, the movement of the dumper between the loading site and the unloading site, and the unloading of the dumper can most preferably be fully
25 automated under the control of control means. The control means correspondingly preferably comprise at least means for emptying the bucket of the loader and for guiding the loader at least in the emptying area automatically, means for guiding the movement of the loader automatically to fetch the material from a predefined site, to guide the loader to move automatically between its loading
30 site and the emptying area, and to empty the material in the bucket automatically to the dumper. Further, the control means preferably comprise means for guiding the dumper to move automatically between the loading area and unloading site, to unload automatically at the unloading site, and to automatically guide the movement of the dumper in the loading area.

35 **[0019]** The measuring device of the load can, as shown in Figure 2, be above the loading area or one or more measuring devices can be mounted

below the guide edge 11, for instance, or obliquely in front or after it in the longitudinal direction of the loader. Two or more measuring devices can naturally be used instead of just one, when it is necessary for the measurement. By using the measuring device 12 or the information obtained from it, it is possible to

5 detect by means of comparison data programmed in advance in the computer when the load on the box at a given location is appropriate, and on the basis of this to guide both the dumper and the loader during loading. Two- or three-dimensional measurements, which are generally known per se, can be used to determine the height of the load and possibly also its shape. The measuring

10 devices also help to ensure the safety of the entire operation. Thus, it is possible to detect with the measuring devices the presence of the dumper on the loading site and its correct location before the loader is permitted to empty its bucket. If the dumper is not there or its location is not correct, this is indicated to the loader by transmitting a suitable control signal that prevents the loader

15 from emptying its bucket. This is an especially useful embodiment when using an either fully automated loader or both an automated loader and dumper.

CLAIMS

1. A method for loading a dumper with broken rock or a corresponding material automatically in such a manner that on a predefined loading site several bucketfuls of the material being loaded are loaded by a loader on a
5 dump box in such a manner that the loader approaches the dumper transverse to it so as to be able to empty the material in the bucket of the loader onto the dump box, **characterized** in that the loading site has a predefined loading area, where the dumper is stopped in a predefined position for loading; that a predefined emptying area is defined for the loader in said loading area at the
10 side of the dumper, to which the loader drives for the purpose of emptying the material in its bucket on the box of the dumper; that the running of the loader in the emptying area and the emptying of its bucket and/or the movement of the dumper in its loading area is automated under the control of control means, that to fill the box of the dumper in the desired manner in transverse direction,
15 the loader is stopped at different points transverse to the dumper, and thus longitudinal to the loader, according to the filling degree of the box and depending on the loading situation of the dump box area being loaded at the time; and that to load the dump box in its longitudinal direction in the desired manner, the dumper is moved, when one area of the box has been loaded, in
20 longitudinal direction or the emptying area of the loader is moved in the longitudinal direction of the dumper a predefined distance so as to load the next area of the box.

2. A method as claimed in claim 1, **characterized** in that the dumper is stopped for loading at one end of the loading area so that one end
25 of the dump box is in the emptying area of the loader and that after said end of the box is filled, the dumper is moved in its longitudinal direction said predefined distance so as to load the next area of the box.

3. A method as claimed in claim 1 or 2, **characterized** in that stopping points are defined in advance for the loader in the emptying area in
30 the travel direction of the loader for loading different transverse points of the dump box.

4. A method as claimed in any one of the preceding claims, **characterized** in that the height of the load on the dump box at the point being loaded is measured with a separate measuring device and that the
35 loading is controlled on the basis of said measured load height.

5. A method as claimed in any one of claims 1 to 4, **characterized** by measuring the shape of the load at the point of the dump box being loaded and the loading is controlled on the basis of the measured shape.

6. A method as claimed in claim 4 or 5, **characterized** in that
5 said measuring device checks the presence and correct location of the dumper in the loading area before the loader is permitted to empty its bucket.

7. A method as claimed in any one of claims 1 to 4, **characterized** in that the weight of the load on the dump box and its location in relation to the box are measured and the loading is controlled on the basis of
10 these measured values.

8. A method as claimed in any one of the preceding claims, **characterized** in that in that the loading area of the dumper is located substantially lower than the emptying area of the loader.

9. A method as claimed in claim 8, **characterized** in that the
15 material dropping from the loader bucket is guided to the dump box by means of a separate downwards-convergent guide edge above the dump box.

10. A method as claimed in any one of the preceding claims, **characterized** in that the loader is guided by the control means to automatically fetch material from a predefined area, to automatically run between the area and the emptying area and to automatically empty the material
20 from its bucket to the dumper.

11. A method as claimed in any one of the preceding claims, **characterized** in that by means of the control means, the dumper is guided to automatically run between its loading site and unloading site and to
25 automatically unload on the unloading site.

12. An apparatus for implementing the method of claim 1, **characterized** in that the apparatus comprises control means for guiding the dumper at least during loading, that the control means comprise means for stopping the dumper in the loading area in a predefined position in such a
30 manner that the material transported by the loader can be emptied on the dump box in a predefined area in its longitudinal direction and, after the dump box is loaded in a certain longitudinal area of the box in the desired manner, for moving the dumper in its longitudinal direction or moving the emptying area of the loader in the longitudinal direction of the dumper a predefined distance
35 so as to load the next area of the box, and that the control means comprise means for automatically guiding the loader in the emptying area to a suitable

emptying point for loading and/or for automatically guiding the movement of the dumper in its loading area.

13. An apparatus as claimed in claim 12, **characterized** in that it comprises at least one separate measuring device for measuring the height of the load on the box and for controlling the loading on the basis of the measured load height.

14. An apparatus as claimed in claim 12 or 13, **characterized** in that it comprises at least one separate measuring device for measuring the shape of the load on the box and for controlling the loading on the basis of the measured load shape.

15. An apparatus as claimed in any one of claims 12 to 14, **characterized** in that at least one separate measuring device is arranged to detect the presence of the dumper and its location in the loading area before the loader is permitted to empty its bucket.

16. An apparatus as claimed in any one of claims 12 to 15, **characterized** in that it comprises measuring means for measuring the weight and location of the load on the dump box and for controlling the loading on the basis of the thus measured values.

17. An apparatus as claimed in any one of claims 12 to 16, **characterized** in that the control means comprise control devices for automatically guiding the loader in the transverse direction of the dumper on the basis of the loading situation of the dump box.

18. An apparatus as claimed in any one of claims 12 to 17, **characterized** in that the control means comprise means for automatically moving the dumper in longitudinal direction according to the loading situation.

19. An apparatus as claimed in any one of claims 12 to 17, **characterized** in that the control means comprise means for moving the emptying area of the loader in the longitudinal direction of the dumper according to the loading situation and for automatically guiding a loading table to the current emptying area.

20. An apparatus as claimed in any one of claims 12 to 19, **characterized** in that the control means comprise means for controlling the movement of the loader to automatically fetch material from a predefined place, to automatically guide the loader to move between the loading site and the emptying area and to automatically empty the material from the loader bucket to the dumper.

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21. An apparatus as claimed in any one of claims 12 to 20, **characterized** in that the control means comprise means for guiding the dumper to automatically move between its loading area and unloading area and to automatically empty the dumper load in the unloading area.

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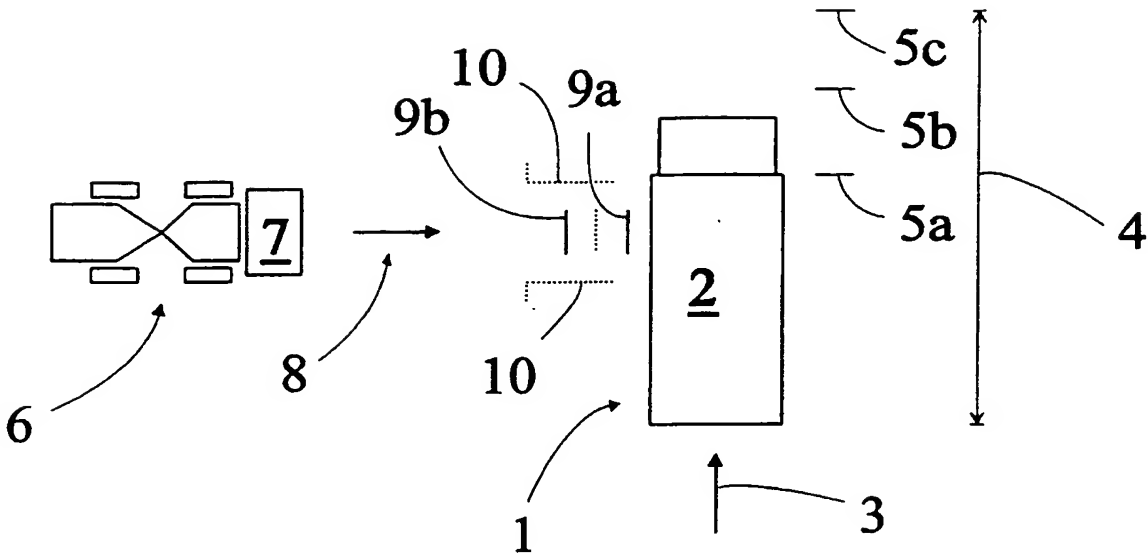


FIG. 1

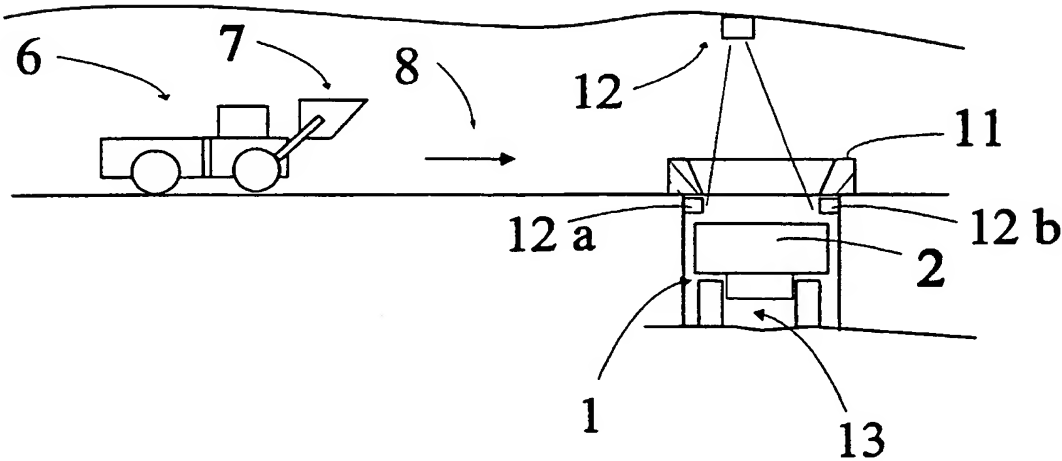


FIG. 2

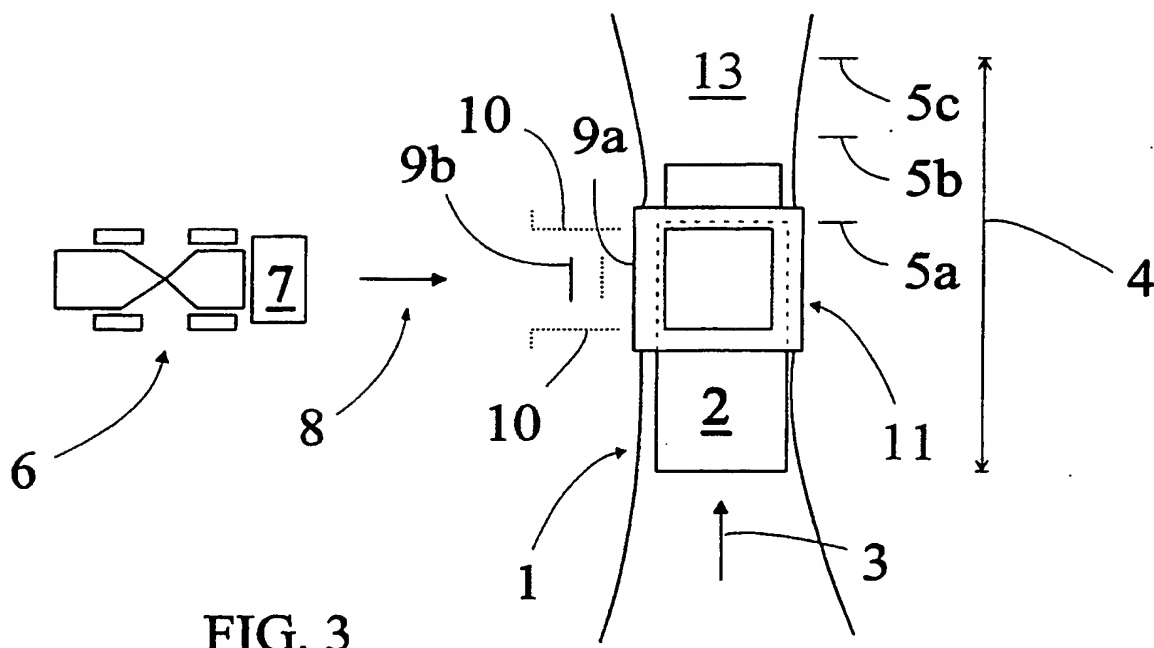


FIG. 3

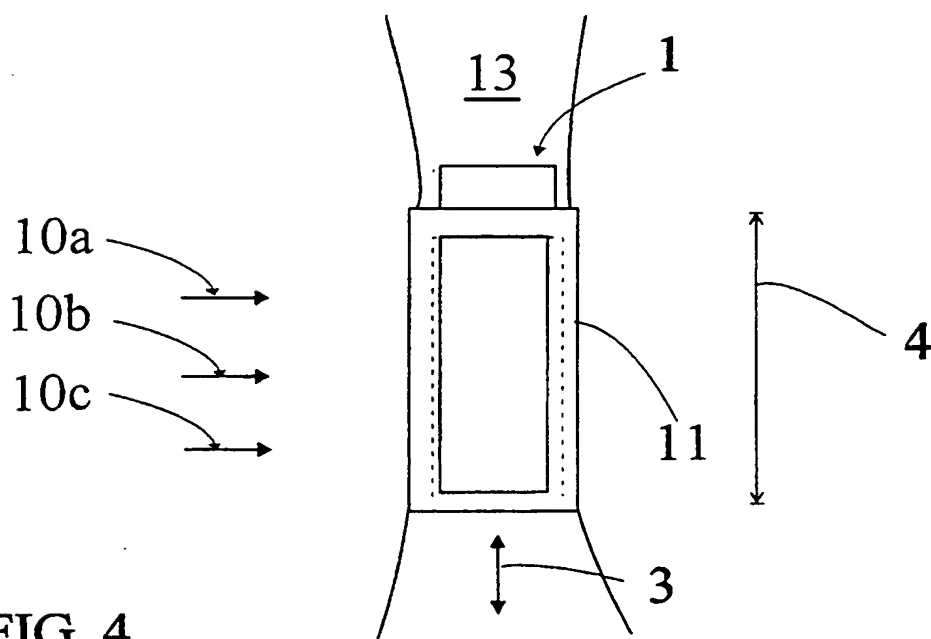


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 02/00317

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B65G 69/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI-DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 6298374 A (KOMATSU LTD), 25 October 1994 (25.10.94) --	1-21
A	JP 6102930 A (KOMATSU LTD), 15 April 1994 (15.04.94) --	1-21
A	SU 695933 A (COAL IND AUTOM PLAN), 5 November 1979 (05.11.79), abstract --	1-21
A	SU 1173190 A (INGULETSKIJ GORNOOBOGATITELNYJ), 15 August 1985 (15.08.85) -- -----	1-21

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Information on patent family members

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International application No.

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JP	6102930	A	15/04/94	NONE	
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